

ENGINEERING ENZYMES TO CONTROL THE CHAIN-LENGTH SELECTIVITY OF BIOSYNTHESIZED OLEOCHEMICALS

Brian F Pfleger, University of Wisconsin-Madison, Chemical and Biological Engineering, USA
Brian.pfleger@wisc.edu

Key Words: Oleochemical, metabolic engineering, thioesterase, fatty acid, Escherichia coli.

Oleochemicals, a class of aliphatic molecules derived from lipids, are used in a range of applications including transportation fuels, consumer products (e.g. cosmetics, shampoo, cleaners), and industrial products (e.g. surface coatings, paints, lubricants, bioplastics). The most common oleochemicals are surfactants (e.g. sodium dodecyl sulfate) and biodiesel. Currently, the majority of oleochemicals are made from inexpensive lipid sources such as plant oils. Growing demand for oleochemicals, and in particular biodiesel, has led to an increased production of plant oil crops and raised concern about the sustainability and environmental impact of oil seed production. Consequently, interest in identifying alternative oleochemical feedstocks has grown. Many types of oleochemicals (e.g. free fatty acids, alcohols, methyl-ketones, olefins, alkanes, esters) have been produced in engineered microbes grown on a variety of carbon sources. That said, products made this way are not widely available. At least three major barriers remain — high feedstock costs, low yields, and a lack of selectivity towards desired molecules.

In this talk, I will discuss the development of enzymes capable of targeting the highly valued medium chain length products. I will describe pathways for producing high-value commodity chemicals derived from fatty-acids and how my group and others have combined synthetic biology and systems biology to improve oleochemical production in bacteria using sustainable feedstocks. I will highlight the use of heterologous plant and bacterial enzymes to alter the chain length distribution of products from common long-chain molecules to higher-value medium-chain analogs. I will describe bioprospecting, structure-guided mutagenesis, and directed evolution approaches that have successfully increased the selectivity and/or activity of enzymes to produce eight-carbon chain-length products. I will conclude with commentary on the remaining barriers to commercializing these technologies and areas where further research investment could prove fruitful.